2002 NEPOOL MARGINAL EMISSION RATE ANALYSIS

for

THE NEPOOL ENVIRONMENTAL PLANNING COMMITTEE

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by

ISO New England Inc.

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1. EXECUTIVE SUMMARY

ISO New England has conducted a study to analyze the impact that demand side management (DSM) programs have had upon New England Power Pool's (NEPOOL) aggregate SO_2, NO_X, and CO_2 generating unit emissions. The *2002 NEPOOL Marginal Emission Rate Analysis Report* (MEA Report) provides an estimate of marginal SO_2, NO_X, and CO_2 emissions for the calendar year 2002. The results of the 2002 marginal emission rate calculations, in Lbs./MWh and Lbs./MBtu, are shown in Table 1.1 and Table 1.2. The NEPOOL EPC has published MEA reports for calendar years 1993 through 2001.

Table 1.1: 2002 Marginal Emission Rates (Lbs./MWh)

2002 Marginal Emission Rates (Lbs./MWh)					
	On-Peak	Off-Peak	On-Peak	Off-Peak	
Emission	Ozone Season	Ozone Season	Non-Ozone Season	Non-Ozone Season	Annual Average
SO_2	3.68	2.00	4.88	2.99	3.27
NO_X	1.37	0.76	1.51	1.01	1.12
CO_2	1,412.2	1,170.6	1,535.6	1,299.5	1,337.8

Table 1.2: 2002 Marginal Emission Rates (Lbs./MBtu)

2002 Marginal Emission Rates (Lbs./MBtu)					
	On-Peak	Off-Peak	On-Peak	Off-Peak	
Emission	Ozone Season	Ozone Season	Non-Ozone Season	Non-Ozone Season	Annual Average
SO_2	0.43	0.23	0.57	0.35	0.38
NO_X	0.16	0.09	0.18	0.12	0.13
CO_2	164.4	136.3	178.8	151.3	155.7

These values were developed using the PROSYM production simulation model under two scenarios. The Reference Case scenario was meant to simulate, as closely as possible, the actual operation of the NEPOOL system during the year 2002. To calculate the amount of additional (marginal) SO_2, NO_X, and CO_2 emissions that would have been emitted if DSM programs were not in place, the second or Marginal Case was created by increasing all hourly loads by 500 MW (incremental load increase). The difference in total emissions between the two cases was calculated in Lbs./MWh and the resultant values are noted above in Table 1.1. A 2002 Marginal Heat Rate was calculated using simulation results and used to convert the Marginal Emission Rate in Lbs./MWh to Lbs./MBtu. The formula used to calculate the Marginal Heat Rate is:

$$\text{2002 Marginal Heat Rate} = \frac{\text{(Marginal Case Fuel Consumption – Reference Case Fuel Consumption)}}{\text{(Marginal Case Generation – Reference Case Generation)}}$$

The 2002 Marginal Heat Rate was calculated to be: 8.66 MBtu/MWh.

2. BACKGROUND

In early 1994, the NEPOOL Environmental Planning Committee (EPC) conducted a study to analyze the impact that DSM programs had on NEPOOL's NO_X emissions in the calendar year 1992. The results were presented in a report entitled, *1992 Marginal NO_X Emission Rate Analysis*, which was used to support applications for obtaining NO_X emission reduction credits (ERCs) resulting from those DSM program impacts. Such applications were filed under the Massachusetts ERC banking and trading program, which became effective on January 1, 1994. The ERC program allows inventoried sources of NO_X, VOCs, and CO_2 in Massachusetts to earn bankable and tradable credits by reducing emissions below regulatory requirements. One of the creditable activities is electric utility DSM programs installed since January 1, 1992. In 1994, the *1993 Marginal Emission Rate Analysis (MEA Report)* was published, which provided analysis on the impact of DSM programs on SO_2, NO_X, and CO_2 emissions for the calendar year 1993. The MEA Report was also published for the years 1994 through 2001 to provide similar analysis.

The *2002 NEPOOL Marginal Emission Rate Analysis Report* provides an estimate of the impact of DSM programs on NEPOOL's SO_2, NO_X, and CO_2 emissions for the calendar year 2002. In today's world, the MEA Report is used by a variety of stakeholders including consulting firms, environmental advocacy groups, and state air regulators. For example, the MEA Report can be used to gauge the value (avoided emissions) of Renewable Energy Certificates (REC) by providing both REC suppliers and stakeholders with a consistent methodology that results in the calculation and communication of the environmental benefits of RECs and works to enhance the overall REC marketplace.

3. METHODOLOGY

3.1. Models Used

For conducting the 2002 Marginal Emissions Analysis, ISO New England used the Henwood Energy Services, Inc. (HESI) standardized database platform called Electric Market Simulation System (EMSS™[1]). EMSS manages the data for the desired market and creates input files to support the chronological production simulation software, PROSYM™[2]. The PROSYM production simulation model was used to replicate, as closely as possible, actual 2002 NEPOOL system operations. However, because PROSYM is a chronological simulation model, there are modeling limitations and it is not possible to exactly replicate the discrete hourly events that occurred historically, such as daily changes in fuel prices, sudden forced outages, and unit deratings. PROSYM's simulation of the 2002 NEPOOL system approximates the minimization of costs using the traditional short-run marginal cost based methodology. The PROSYM production simulation model simulates the NEPOOL power system as a one-bus model and thus the impacts resulting from transmission constraints are not captured.

3.2. Calculating Marginal Emissions

Marginal emissions are calculated by comparing two simulations. The Reference Case was created to replicate, as closely as possible, the actual 2002 NEPOOL system operation. The Reference Case is created by running the PROSYM model and comparing the calculated annual energies to the actual energies on a unit by unit basis. If a unit's calculated annual energies are not within 25% of the actual annual energy, the unit variable costs are adjusted and the program is re-run. This process is continued until all unit's calculated annual energies are within 25% of the actual annual energies. Because of modeling constraints, quick-start capacity is not considered in the 25% analysis of actual vs. calculated

[1] Henwood Energy Services, Inc.- EMSS version 4.4.03.
[2] Henwood Energy Services, Inc.- PROSYM version 3.7.00.

annual energy production. To calculate the amount of additional (marginal) emissions that would have been emitted if DSM programs were not in place, a Marginal Case is created by increasing all hourly loads by 500 MW (incremental load increase). The MEA Report was originally produced to estimate the impacts of DSM programs on the NEPOOL system.

The 1994 Report entitled, *NEPOOL Forecast Report of Capacity, Energy, Loads and Transmission 1994-2009 (1994 CELT Report),* identified 1994 aggregate summer DSM programs in the amount of 1,034 MW. The reason why an incremental 500 MW was originally used to estimate the impacts from DSM programs was that that amount was an average or in-between point. Marginal emission rates could have been calculated for the first (1) MW of incremental load and could also have been calculated for the 1,034 MW of incremental load. In 1994, the NEPOOL Environmental Planning Committee (EPC) decided to model the average effects of not having DSM programs at the average or in-between point of 500 MW incremental load. Additionally, the 500 MW incremental load has been used in all MEA Reports since 1994, and thus provides a consistent base line for historical observations. The 2003 Report entitled, *NEPOOL Forecast Report of Capacity, Energy, Loads and Transmission 2003-2012 (2003 CELT Report)*, identifies 2002 summer DSM programs totaling 1,576 MW and winter DSM programs totaling 1,487 MW.

ISO New England dispatches all the generating units in NEPOOL (New England) economically to meet the hourly load and operating reserve requirements, subject to transmission constraints, contingency protection, self-scheduling of units, and Reliability Must-Run (RMR) contracts. This means that multiple units may increase output in response to an increase in load. Therefore, there is no single marginal unit that can be identified at any given time. Rather, typically there are multiple marginal units located throughout the six New England states.

This report calculates 2002 NEPOOL marginal SO_2, NO_X, and CO_2 emission rates that are expressed in both Lbs./MWh and Lbs./MBtu. Also included, by SMD Load Zone, is incremental tons of emissions and energy consumption. This data is calculated by increasing the actual 2002 NEPOOL loads by 500 MW in all hours. Based on a comparison between the two simulations, Reference Case vs. Incremental Case, monthly differences in energy output and the corresponding SO_2, NO_X, and CO_2 emissions are then determined. These marginal emission rates are based on calculated energy production in 2002 and other discretely modeled system conditions. Caution should be exercised in using this information for years other than 2002. It should also be noted that although Reference Case simulations approximately match actual operation, the simulations are run on a single-bus model and are subject to differences from actual hourly dispatch. The final hourly NEPOOL marginal emissions are divided into the four time-periods described below.

1. On-Peak Ozone Season (where the Ozone Season is defined as occurring from May 1 to September 30) consisting of all weekdays between hour ending 9 A.M. and hour ending 10 P.M. from May 1 to September 30.
2. Off-Peak Ozone Season consisting of all weekdays between hour ending 11 P.M. and hour ending 8 A.M. and all weekends from May 1 to Septermber 30.
3. On-Peak Non-Ozone Season consisting of all weekdays between hour ending 9 A.M. and hour ending 10 P.M. from January 1 to April 30 and October 1 to December 31.
4. Off-Peak Non-Ozone Season consisting of all weekdays between hour ending 11 P.M. and hour ending 8 A.M. and all weekends from January 1 to April 30 and October 1 to December 31.

4. ASSUMPTIONS

The key parameters and assumptions modeled within the 2002 Marginal Emissions Rate Analysis are highlighted below.

- Complete forced and scheduled outages were modeled discretely within the maintenance schedule as they occurred in actuality. This gives the best possible method for modeling the 2002 actual outage occurrences.
- NEPOOL DSM programs for 2002 have been modeled at the average aggregate of 500 MW in all hours.
- Actual historical hourly loads for 2002 were modeled for the NEPOOL system.
- The actual hourly net interchange with external systems, New York, New Brunswick, and Hydro-Quebec, was netted out from the actual historical hourly NEPOOL loads. This results in the modeling of native NEPOOL load and generation only. NEPOOL pumped-storage pumping load is included within the hourly NEPOOL loads.
- For all major dispatchable hydro-electric stations, all pumped storage facilities, and several large non-dispatchable or self-scheduled units, actual 2002 monthly energies were input into all modeling runs and those units were modeled as Limited Energy units. All of the Limited Energy units were dispatched within PROSYM to meet their target 2002 actual monthly energies. Dispatchable generators were operated according to system economics.
- For generating units with dual fuel capability, fuel-switching assumptions were based on the Environmental Protection Agency's (EPA) raw hourly emissions data and analyzed to distinguish between oil and gas-fired energy production. Further information on this data source can be found on the EPA website.
- Fuel prices for generating units were defaulted to those defined within PROSYM's Electric Market Simulation System (EMSS) database. In the EMSS database, the natural gas prices for the year 2002 were taken from historical NYMEX prices plus average transportation costs, coal prices were extracted from 2002 FERC Form 423, and fuel oil prices were extracted from historical settlement prices for New York Harbor and West Texas and added with an average transportation cost for the New England region.
- The generating unit emission rates were calculated from the 2002 actual emissions as reported to the US EPA's Acid Rain Division and published in the preliminary US EPA Emissions Scorecard 2002[1]. For those units that were not required to file with the US EPA Acid Rain Division, the assumed emission rates were either the rate noted in EPA's E-Grid2002 version 2.0 data or provided through HESI's database version 6.5.0.

[1] Final data was not available from the US EPA as of November 1, 2003

5. RESULTS

5.1. 2002 Marginal Heat Rate

In MEA reports prior to 1999, a fixed Marginal Heat Rate of 10.0 MBtu/MWh was used to convert from Lbs./MWh to Lbs./MBtu. In the 1999 –2002 *NEPOOL Marginal Emissions Analysis Report*, the Marginal Heat Rate was calculated using the results of the modeling runs. This methodology has again been used to calculate the 2002 Marginal Heat Rate. Since heat rate is equal to fuel consumption divided by generation, the 2002 Marginal Heat Rate is defined as follows:

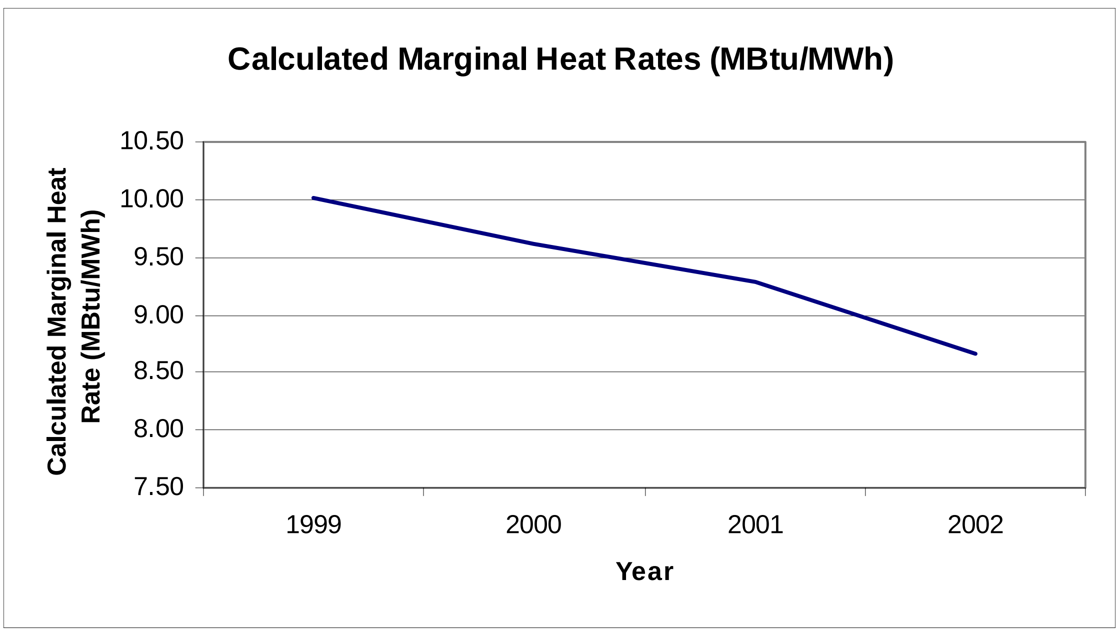
$$\text{2002 Marginal Heat Rate} = \frac{\text{(Marginal Case Fuel Consumption – Reference Case Fuel Consumption)}}{\text{(Marginal Case Generation – Reference Case Generation)}}$$

The marginal heat rate reflects the efficiency of the units dispatched to meet the additional load requirement in the marginal case. Generally, the lower the heat rate value, the more efficient the system is.

The 2002 Marginal Heat Rate was calculated to be:	8.660	MBtu/MWh
The 2001 Marginal Heat Rate was calculated to be:	9.279	MBtu/MWh
The 2000 Marginal Heat Rate was calculated to be:	9.610	MBtu/MWh
The 1999 Marginal Heat Rate was calculated to be:	10.013	MBtu/MWh

The 2002 Marginal Heat Rate has decreased since 1999 from 10.013 MBtu/MWh to 8.660 MBtu/MWh. This is primarily due to the addition of low emitting gas-fired combined cycle units with high efficiency rates. Figure 5.1 illustrates the calculated marginal heat rate spanning the 1999 – 2002 timeframe.

Figure 5.1: Calculated Marginal Heat Rate (MBtu/MWh)



To convert from Lbs./MWh to Lbs./MBtu, the 2002 Marginal Heat Rate is used as the global conversion factor for all calculations within this report.

5.2. Incremental Generation By SMD Load Zones

Table 5.1 shows the incremental generation, by SMD load zones, for the Ozone Season and Non-Ozone Season time-periods. Also shown is the percent of total NEPOOL generation increase, by SMD load zones, resulting from a 500 MW increase in all NEPOOL hourly loads.

Compared to 2001 results, Incremental generation share from units in the MA SMD Load Zones decreased while Incremental generation share from units in the RI SMD load zone increased significantly. This is due to the commercialization of many units in 2002.

Table 5.1: 2002 Incremental Generation By SMD Load Zones

2002 Incremental Generation By SMD Load Zones						
	Ozone Season		Non-Ozone Season		Annual	
State	GWh	%	GWh	%	GWh	%
CT	350.1	19.1	621.4	24.4	971.6	22.2
ME	269.4	14.7	346.6	13.6	616.0	14.1
NH	120.4	6.6	231.2	9.1	351.6	8.0
RI	299.2	16.3	489.4	19.2	788.6	18.0
VT	11.7	0.6	8.3	0.3	20.0	0.5
MA	785.2	42.8	847.0	33.3	1,632.2	37.3
MA (Divided in Load Zones)						
Northern MA & Boston	157.5	8.6	199.4	7.8	356.9	8.1
Southeastern MA	408.7	22.3	460.5	18.1	869.2	19.8
Western & Central MA	218.9	11.9	187.2	7.4	406.1	9.3
Total	***1,836.0***	***100.0***	***2,544.0***	***100.0***	***4,380.0***	***100.0***

5.3. 2002 Marginal Emission Rates

Table 5.2 shows SO_2, NO_X and CO_2 marginal emission rates in Lbs./MWh for the NEPOOL system for each of the four time-periods. Table 5.3 shows the same information expressed in Lbs./MBtu. As noted earlier, the 2002 Marginal Heat Rate of 8.66 MBtu/MWh was used as the global conversion factor.

The overall NEPOOL emissions and operating reserve for each state are very dependent on the specific units that are seasonally available to serve NEPOOL load. Therefore, there could be wide variations in the seasonal emissions, primarily due to changes in unit availability, fuel consumption, and load level.

Table 5.2: 2002 Marginal Emission Rates (Lbs./MWh)

2002 Marginal Emission Rates (Lbs./MWh)					
	On-Peak	Off-Peak	On-Peak	Off-Peak	
Emission	Ozone Season	Ozone Season	Non-Ozone Season	Non-Ozone Season	Annual Average
SO_2	3.68	2.00	4.88	2.99	3.27
NO_X	1.37	0.76	1.51	1.01	1.12
CO_2	1,412.2	1,170.6	1,535.6	1,299.5	1,337.8

Table 5.3: 2002 Marginal Emission Rates (Lbs./MBtu)

2002 Marginal Emission Rates (Lbs./MBtu)					
	On-Peak	Off-Peak	On-Peak	Off-Peak	
Emission	Ozone Season	Ozone Season	Non-Ozone Season	Non-Ozone Season	Annual Average
SO_2	0.43	0.23	0.57	0.35	0.38
NO_X	0.16	0.09	0.18	0.12	0.13
CO_2	164.4	136.3	178.8	151.3	155.7

5.4. Calculated Historical Marginal Emission Rates

Table 5.4 through Table 5.6 illustrates the calculated marginal emission rates for SO_2, $NO_{x,}$ and CO_2 in Lbs./MWh for the years 1993 through 2002. Figure 5.2 through Figure 5.4 are graphical representations of Table 5.4 through Table 5.6, respectively. There is a noticeable decrease in the marginal emission rates for NO_x in 1995 primarily due to the implementation of NO_x RACT regulations as required under Title I of the 1990 Clean Air Act Amendments. This decrease in the calculated NO_X marginal emission rate continues into the 2002 time-frame. Most of the continued decrease can be attributed to the addition of many new gas-fired combined cycled plants in each year[1]. In 2002, there was almost 2,300 MW of new gas-fired capacity added to the system. Along with the increase in natural gas-fired capacity, the historical cost of fuel modeled within PROSYM also affects the calculated marginal emission rates.

The increase in natural gas-fired capacity has also had an affect on the calculated CO_2 marginal emission rates during the ozone off-peak period. Specifically, a decrease can be seen in the 2002 calculated CO_2 marginal rate from the year 2000. This decrease is due to the increase in natural gas-fired marginal generation coupled with the decrease in coal-fired marginal generation during the ozone off-peak period.

In 1997 to 1998, there is an increase in the marginal emission rates for CO_2 primarily due to the lower availability in nuclear generation and the subsequent increase in fossil-fired generation to compensate for that loss. A drop in annual marginal emission rates into 2000 and 2002 is most likely the result of the addition of the newly commercialized, highly efficient, low emitting natural gas-fired generating plants in New England. The slight increase in the calculated CO_2 marginal emission rate during the Non-Ozone On-Peak Period from 2001 to 2002 is attributed to a large amount of marginal generation from lower cost coal-fired units in 2002, when compared to the 2001 MEA results. In 2001, natural gas prices were high and therefore, coal units ran at a high capacity factor during the on-peak periods. This however, does not allow for a large increase in coal-fired generation in the 2001 marginal case. In 2002, natural gas prices declined and became competitive with other fossil-fuels. Therefore, when the 2002 marginal case is simulated, coal-fired generation is available to meet the marginal demand and the resultant increase in coal-fired generation during this time, results in a higher calculated CO_2 marginal emission rate.

Overall, results for 2002 illustrate that marginal emission rates continue to decline with the commercialization of additional highly efficient natural gas-fired generating plants.

[1] See Appendix Table A.2 through Appendix Table A.4

Table 5.4: Calculated SO2 Marginal Emission Rates (Lbs./MWh)

Calculated SO_2 Marginal Emission Rates (Lbs./MWh)					
	On-Peak	Off-Peak	On-Peak	Off-Peak	
Year	Ozone Season	Ozone Season	Non-Ozone Season	Non-Ozone Season	Annual Average
1993	10.4	14.0	11.2	14.9	12.6
1994	9.4	8.6	10.9	10.4	9.8
1995	8.0	5.6	8.0	6.5	7.0
1996	9.5	9.0	10.6	9.1	9.6
1997	7.4	10.0	9.4	10.6	9.4
1998	6.6	4.9	6.8	6.6	6.2
1999	7.8	6.5	7.3	7.3	7.2
2000	6.6	6.0	6.3	5.9	6.2
2001	5.3	4.4	5.1	5.0	4.9
2002	3.7	2.0	4.9	3.0	3.3

Table 5.5: Calculated NOx Marginal Emission Rates (Lbs./MWh)

Calculated NO_X Marginal Emission Rates (Lbs./MWh)					
	On-Peak	Off-Peak	On-Peak	Off-Peak	
Year	Ozone Season	Ozone Season	Non-Ozone Season	Non-Ozone Season	Annual Average
1993	4.0	4.5	4.1	5.0	4.4
1994	4.5	3.9	4.5	3.9	4.2
1995	3.4	2.8	3.5	3.1	3.2
1996	2.7	2.4	2.9	2.4	2.6
1997	2.6	2.6	2.7	2.6	2.6
1998	2.2	2.0	2.1	2.1	2.1
1999	2.2	2.0	1.9	1.8	2.0
2000	2.0	1.8	1.8	1.8	1.9
2001	1.9	1.5	1.7	1.6	1.7
2002	1.4	0.8	1.5	1.0	1.1

Table 5.6: Calculated CO2 Marginal Emission Rates (Lbs./MWh)

Calculated CO_2 Marginal Emission Rates (Lbs./MWh)					
	On-Peak	Off-Peak	On-Peak	Off-Peak	
Year	Ozone Season	Ozone Season	Non-Ozone Season	Non-Ozone Season	Annual Average
1993	1,630.0	1,610.0	1,580.0	1,750.0	1,642.5
1994	1,767.0	1,334.0	1,796.0	1,396.0	1,573.3
1995	1,654.0	1,458.0	1,713.0	1,511.0	1,584.0
1996	1,696.0	1,575.0	1,752.0	1,590.0	1,653.3
1997	1,437.0	1,522.0	1,487.0	1,488.0	1,483.5
1998	1,621.7	1,431.9	1,537.6	1,490.6	1,520.4
1999	1,643.6	1,549.6	1,586.9	1,530.6	1,577.7
2000	1,544.7	1,504.7	1,462.8	1,440.1	1,488.1
2001	1,436.5	1,340.2	1,406.0	1,392.9	1,393.9
2002	1,412.2	1,170.6	1,535.6	1,299.5	1,337.8

Figure 5.2: Calculated SO2 Marginal Emission Rates

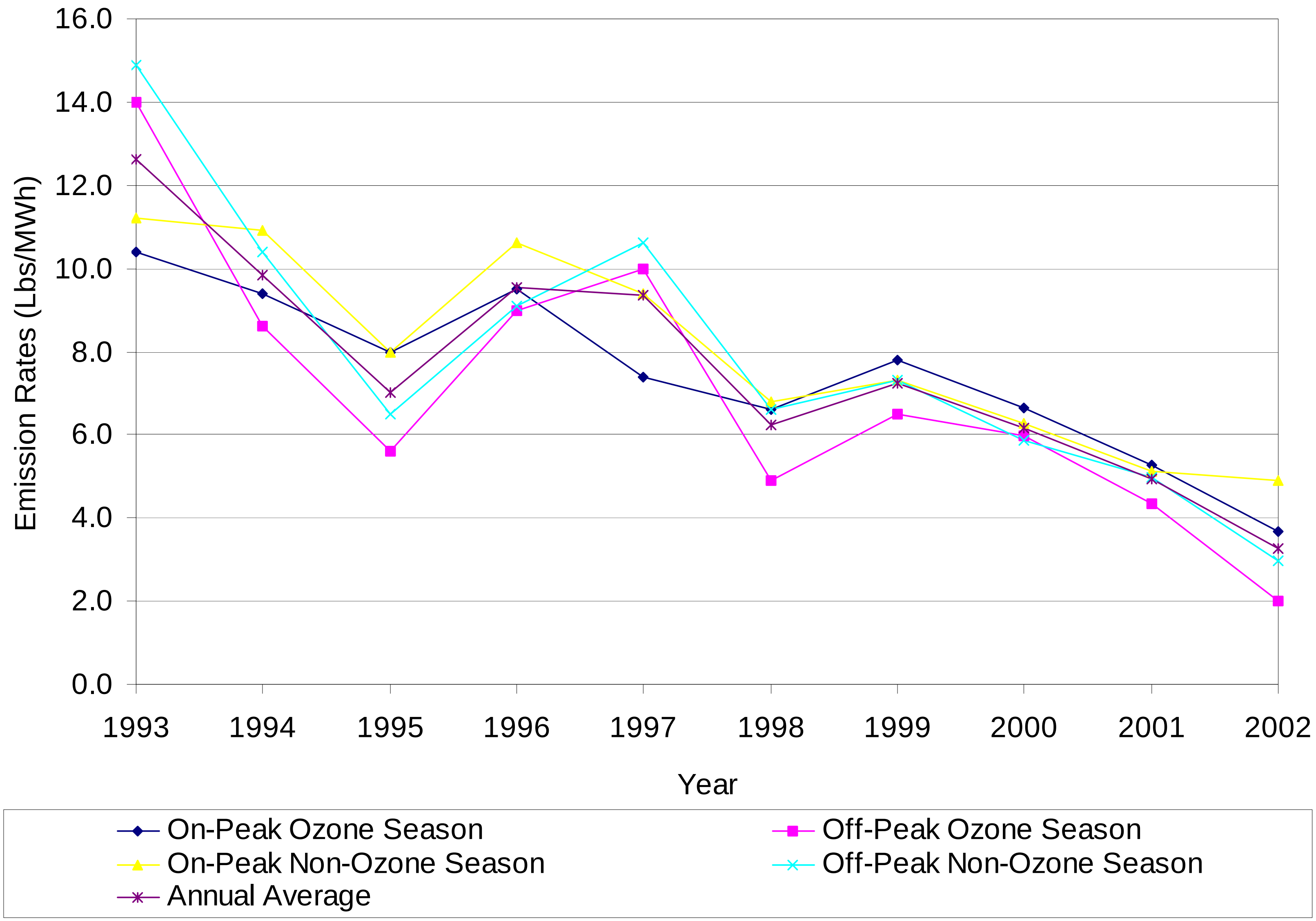


Figure 5.3: Calculated NOX Marginal Emission Rates

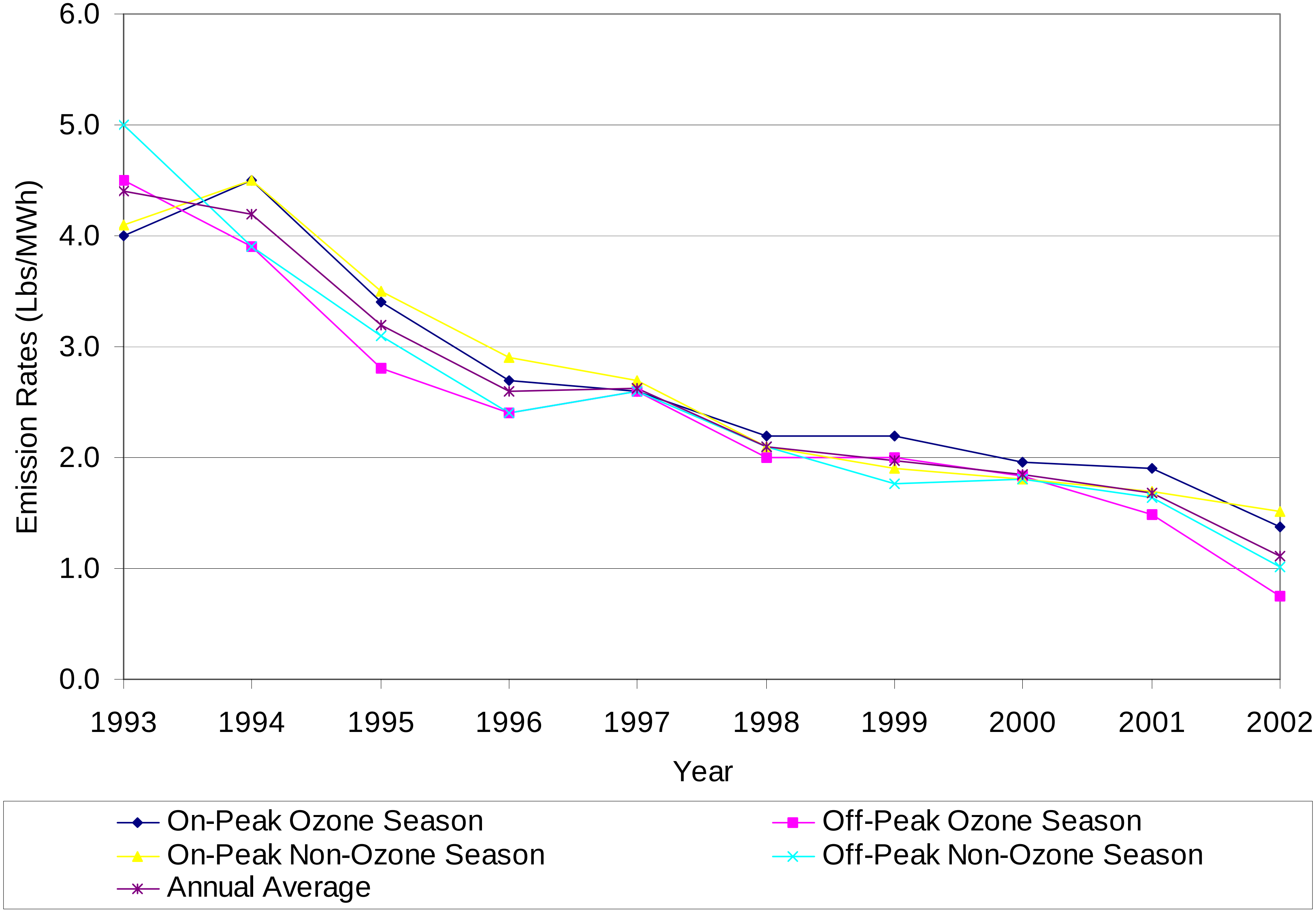
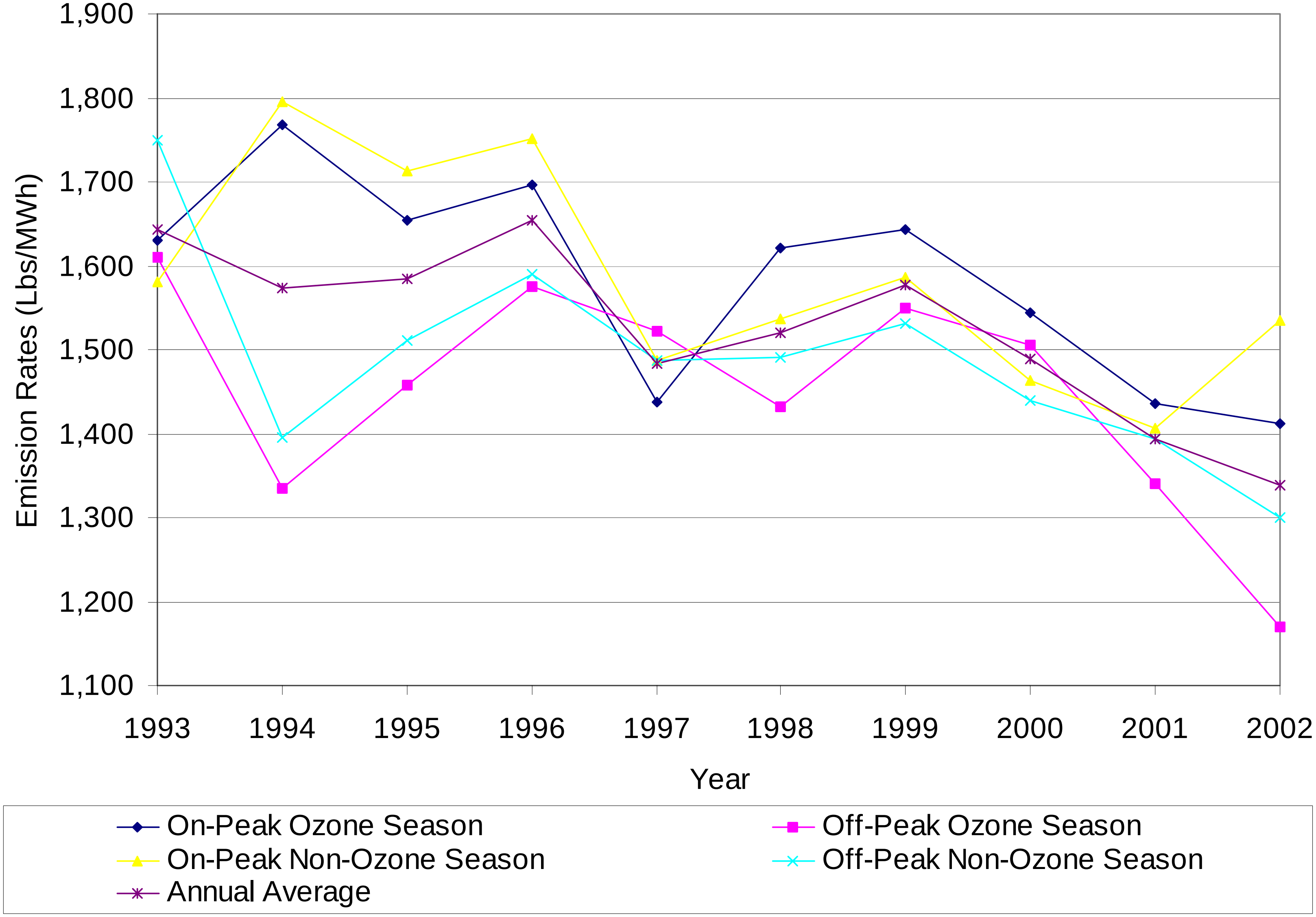


Figure 5.4: Calculated CO2 Marginal Emission Rates



5.5. Incremental Emissions by SMD Load Zone and by Ozone & Non-Ozone Season

Table 5.7 through Table 5.9 illustrates the calculated incremental SO_2, NO_X, and CO_2 emissions, by SMD Load Zone, for the ozone and non-ozone season time-periods, that would have been produced if the total NEPOOL load in all hours was increased by 500 MW. Also shown is the percent of the total increase in emissions that would have correspondingly been produced within each state.

Table 5.7: 2002 Incremental SO2 Emissions

2002 Incremental SO_2 Emissions						
	Ozone Season		Non-Ozone Season		Annual	
State	Tons	%	Tons	%	Tons	%
CT	516.5	20.8	1,534.8	32.4	2,051.3	28.4
ME	153.7	6.2	460.6	9.7	614.3	8.5
NH	172.6	6.9	776.5	16.4	949.1	13.1
RI	0.5	0.0	1.5	0.0	2.0	0.0
VT	0.4	0.0	0.4	0.0	0.8	0.0
MA	1,645.3	66.1	1,966.3	41.5	3,611.6	50.0
MA (Divided in Load Zones)						
Northern MA & Boston	419.7	16.9	760.5	16.0	1,180.2	16.3
Southeastern MA	895.3	36.0	1,028.5	21.7	1,923.8	26.6
Western & Central MA	330.3	13.3	177.3	3.7	507.6	7.0
Total	***2,489.0***	***100.0***	***4,740.1***	***100.0***	***7,229.1***	***100.0***

Notes:
1) The Incremental Emissions are calculated by increasing the actual 2002 NEPOOL loads by 500 MW in all hours.
2) Annual totals may not equal sum due to rounding.

Table 5.8: 2002 Incremental NOX Emissions

2002 Incremental NO_X Emissions

	Ozone Season		Non-Ozone Season		Annual	
State	Tons	%	Tons	%	Tons	%
CT	232.3	24.9	498.2	32.5	730.5	29.6
ME	60.4	6.5	144.9	9.4	205.3	8.3
NH	34.9	3.7	147.3	9.6	182.2	7.4
RI	27.5	2.9	47.5	3.1	75.0	3.0
VT	15.0	1.6	10.5	0.7	25.5	1.0
MA	562.2	60.3	686.8	44.7	1,249.0	50.6
MA (Divided in Load Zones)						
Northern MA & Boston	133.7	14.3	247.1	16.1	380.8	15.4
Southeastern MA	305.0	32.7	352.2	22.9	657.2	26.6
Western & Central MA	123.5	13.2	87.5	5.7	211.0	8.6
Total	***932.3***	***100.0***	***1,535.2***	***100.0***	***2,467.5***	***100.0***

Table 5.9: 2002 Incremental CO2 Emissions

2002 Incremental CO_2 Emissions

	Ozone Season		Non-Ozone Season		Annual	
State	Ktons	%	Ktons	%	Ktons	%
CT	258.7	22.0	535.6	30.2	794.3	26.9
ME	137.3	11.7	205.8	11.6	343.1	11.6
NH	69.4	5.9	172.0	9.7	241.4	8.2
RI	141.2	12.0	232.8	13.1	374.1	12.7
VT	19.2	1.6	13.6	0.8	32.8	1.1
MA	550.2	46.8	613.1	34.6	1,163.3	39.4
MA (Divided in Load Zones)						
Northern MA & Boston	135.6	11.5	188.3	10.6	324.0	11.0
Southeastern MA	278.4	23.7	316.4	17.8	594.8	20.2
Western & Central MA	136.2	11.6	108.3	6.1	244.5	8.3
Total	***1,176.0***	***100.0***	***1,772.8***	***100.0***	***2,948.9***	***100.0***

Notes:
1) The Incremental Emissions are calculated by increasing the actual 2002 NEPOOL loads by 500 MW in all hours.
2) Annual totals may not equal sum due to rounding.

APPENDIX A

Table A.1 shows the total NEPOOL capacity claimed for capability during the 2002 calendar year. NEPOOL capacity listed in Table A.2 was obtained from ISO New England's January 2003 Seasonal Claimed Capability (SCC) Report. Table A.2 – Table A.4 identifies new units that went into commercial during the 2002, 2001, and 2000 calendar year, respectively.

Appendix Table A.1: 2002 NEPOOL Capacity by State and Unit Category

Total NEPOOL Capacity By State and Unit Type as Listed in the January 2003 Seasonal Claimed Capability Report														
	Connecticut		Maine		Massachusetts		New Hampshire		Rhode Island		Vermont		New England Totals	
Unit Category	Summer Net MW	Winter Net MW	Summer Net MW	Winter Net MW	Summer Net MW	Winter Net MW	Summer Net MW	Winter Net MW	Summer Net MW	Winter Net MW	Summer Net MW	Winter Net MW	Summer Net MW	Winter Net MW
Combined Cycle	1,232	1,425	1,378	1,520	2,787	3,189	528	543	1,788	2,049	-	-	7,713	8,726
Diesel	5	5	18	20	83	84	-	-	-	-	14	14	120	123
Fossil	3,026	3,175	1,288	1,299	5,126	5,302	1,082	1,098	12	12	73	74	10,607	10,960
Gas Turbine	338	412	194	231	526	626	14	18	-	-	75	99	1,147	1,386
Hydro	149	156	469	521	312	321	540	561	1	1	144	165	1,615	1,725
Pumped Storage	-	-	-	-	1,643	1,665	-	-	-	-	-	-	1,643	1,665
Jet	322	413	-	-	355	507	68	83	-	-	14	22	759	1,025
Nuclear	2,002	2,014	-	-	667	673	1,158	1,161	-	-	506	529	4,333	4,377
Total	7,074	7,600	3,347	3,591	11,499	12,367	3,390	3,464	1,801	2,062	826	903	27,937	29,987

Appendix Table A.2: New Capacity Added to New England During 2002

New Capacity Added to New England During 2002					
Unit Name	Unit Category	State	Summer Net MW	Winter Net MW	In-Service Date
Wallingford Units 1-5	Gas Turbine	CT	215	251	Jan-02
Lake Road Units 1-2	Combined Cycle	CT	454	525	Mar-02
Lake Road Unit 3	Combined Cycle	CT	237	272	May-02
West Springfield 1 & 2	Gas Turbine	MA	86	100	Jun-02
Newington Energy	Combined Cycle	NH	528	543	Sep-02
RISE	Combined Cycle	RI	515	575	Oct-02
ANP Bellingham Unit 1	Combined Cycle	MA	221	252	Oct-02

Appendix Table A.3: New Capacity Added to New England During 2001

New Capacity Added to New England During 2001					
Unit Name	**Unit Category**	**State**	**Summer Net MW**	**Winter Net MW**	**In-Service Date**
Bucksport	Combined Cycle	ME	165	193	Jan-01
Millenium	Combined Cycle	MA	339	388	Apr-01
Westbrook	Combined Cycle	ME	512	551	Apr-01
ANP Blackstone Unit 1	Combined Cycle	MA	209	213	Jun-01
ANP Blackstone Unit 2	Combined Cycle	MA	214	244	Jul-01

Appendix Table A.4: New Capacity Added to New England During 2000

New Capacity Added to New England during 2000					
Unit Name	**Unit Category**	**State**	**Summer Net MW**	**Winter Net MW**	**In-Service Date**
Androscoggin Energy Center	Combined Cycle	ME	86	109	Jan-00
Berkshire Power	Combined Cycle	MA	248	265	May-00
Maine Independence Station	Combined Cycle	ME	494	547	Jun-00
Tiverton Power	Combined Cycle	RI	251	286	Aug-00

APPENDIX B

Table B.1 illustrates the aggregate SO_2, NO_X, and CO_2 emissions as output from the Reference case production simulation runs and the aggregate emissions as reported to the US EPA on the Preliminary EPA Scorecard 2002. It must be noted that the calculated values are a result of computer simulation limited by certain assumptions and does not precisely match the historical unit commitment and dispatch of generating units. Also, the units that are listed in the Preliminary US EPA Scorecard 2002 account for approximately 70% of the total NEPOOL capacity. This is the primary reason for the delta between the calculated and reported aggregate emissions of SO_2, NO_X, and CO_2 for 2002.

Appendix Table B.1: 2002 Reference Case Calculated Aggregate Emissions of SO_2, NO_X, and CO_2

2002 Reference Case Aggregate Emissions of SO_2, NO_X, and CO_2			
	SO_2	NO_X	CO_2
SMD Load Zone	ktons	ktons	ktons
CT	15.3	9.4	10,785
ME	2.6	3.2	7,146
NH	46.8	8.5	6,480
RI	0.2	0.7	3,148
VT	0.0	0.5	356
Total MA SMD Load Zones	96.1	34.1	26,582
MA (Divided into SMD Load Zones)			
Northern MA & Boston	21.2	7.0	5,549
Southeastern MA	67.5	22.7	16,088
Western & Central MA	7.5	4.4	4,945
Calculated Total	161.1	56.4	54,497
Total as Noted in Preliminary 2002 US EPA Scorecard	147.5	42.2	42,974
Delta	13.5	14.2	11,524

Table B.2 and B.3 illustrates the annual average values, as output from the Reference Case production simulation runs, of SO_2, NO_X, and CO_2 rates in lbs/MBtu and lbs/MWh for the 1999 – 2002 time period. Table B.3 also gives the annual average heat rate for the NEPOOL system spanning the same time frame.

Appendix Table B.2: 1999 – 2002 Calculated Annual Averages of SO_2, NO_X, CO_2 in Lbs/MBtu, and Heat Rates

	Annual Averages			
	SO2 (lbs/Mbtu)	NOX (lbs/Mbtu)	CO2 (lbs/Mbtu)	Heat Rate (Mbtu/MWh)
1999	0.49	0.15	110.35	9.14
2000	0.43	0.12	99.98	9.03
2001	0.39	0.12	103.8	8.96
2002	0.31	0.11	105.1	8.66

Appendix Table B.3: 1999 – 2002 Calculated Annual Averages of SO_2, NO_X, CO_2 in Lbs/MWh

	Annual Averages		
	SO2 (lbs/MWh)	NOX (lbs/MWh)	CO2 (lbs/MWh)
1999	4.52	1.36	1008.73
2000	3.93	1.14	913.91
2001	3.58	1.07	948.89
2002	2.69	0.94	909.40

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